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0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p} preliminary
^{r} revised
x suppressed to meet the confidentiality requirements of the *Statistics Act*
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All-cause and circulatory disease-related hospitalization, by generation status: Evidence from linked data

by Edward Ng, Claudia Sanmartin, Jack V. Tu and Douglas G. Manuel

Abstract

Background: Immigrants tend to have better health than the Canadian-born. However, the "healthy immigrant" effect diminishes over time and varies by source country. This study examines whether lower hospitalization rates persist from the first (G1) to the second generation (G2) of immigrants, compared with other Canadians (G3+). All-cause and circulatory disease-related hospitalization rates were examined by generation, with special attention to people of Chinese and South Asian descent.

Data and methods: Data from the 2006 Census-hospitalization linkage database (which excludes Quebec) were analysed using logistic regression. Age-standardized all-cause (excluding pregnancy) and circulatory disease-related hospitalization rates were derived for the urban population aged 30 or older for the 2006/2007 to 2008/2009 fiscal years.

Results: Over the generations, immigrants' all-cause and circulatory disease-related hospitalization rates converged with those of the Canadian population overall. Compared with G3+, the age-adjusted odds of all-cause hospitalization among men were 0.49 (CI = 0.48-0.51) for recent G1 immigrants, 0.78 (CI = 0.77-0.79) for long-term G1 immigrants, and 0.95 (CI = 0.94-0.97) for G2. Adjustments for socioeconomic status reduced the difference, especially between G2 and G3+. For South Asians, rates converged for circulatory disease, notably among men. Hospitalization rates for people of Chinese descent rose across generations, but remained significantly below rates for G3+.

Interpretation: The lower circulatory disease-related hospitalization risk experienced by G1 is maintained in G2 among people of Chinese descent, but not among South Asians.

Keywords: Cardiovascular diseases, census, Chinese, data linkage, hospital records, immigrant health, medical records, socioeconomic status, South Asian

Since the 1970s, the origins of immigrants to Canada have shifted toward non-European source countries, such as India and China.[1] As a result, 8% of the total population self-identify as South Asian or Chinese, a percentage that is projected to reach about 15% by 2031.[2] Canada's changing ethnic make-up and its long-run impact on subsequent generations can have implications for health care.

While immigrants tend to have better health than the Canadian-born population, variations by disease and by source country are considerable.[3,4] For example, regardless of where they live, South Asians have one of the highest rates of heart/circulatory disease in the world.[5-7] In Canada, circulatory disease mortality risk among South Asians tends to be similar to that of the Canadian-born population, but higher than that of other immigrant/ethnic groups.[3,8,9] Conversely, circulatory disease risk among the Chinese population is relatively low.[10,11] A recent review of immigrant health research found that Canadians of South Asian descent tend to experience increased risks of heart disease and hypertension as duration of residence in Canada lengthens, and noted a need to study the effects from a generational perspective.[12]

Evidence of the extent to which health advantages (or disadvantages) of first-generation immigrants are transferred to future generations is mixed.[13-15] In a 1976 study of immigrant health, Marmot and Syme[16] found a higher prevalence of heart disease among male Japanese immigrants in California and Hawaii than among men in Japan. However, first-generation Japanese immigrants in Hawaii had a lower prevalence of heart disease than the second generation, whose health profiles were closer to those of non-immigrant Hawaiians. In Canada, generational analyses of health tend to focus on youth and school children, specifically risk behaviours and weight gain, with little attention to cardiac health.[17-19] A study of immigrants in Montreal reported no health advantage in obesity or self-rated health among second-generation adults, especially those in disadvantaged neighborhoods.[20]

Information about the use of health care services by generation status is limited. A key barrier is the lack of immigration and generation status variables in administrative health data.[21] Area-based studies have used the percentage of immigrants in a neighbourhood as a proxy for immigrant status,[22] but such ecological approaches are limited. Alternatively, linking administrative health data to sources that contain information on immigrant and generation status opens the possibility for detailed examinations of immigrant health.[3]

This study used data from the 2006 Census of Population (long-form respondents) linked to administrative records to determine if hospitalization patterns among first-generation immigrants persist in the second generation, and if patterns differ between South Asians and Chinese subgroups, when socioeconomic covariates are taken into account.

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Data and methods

Data sources

The 2006 Census (long-form) was linked to the Canadian Institute for Health Information's Discharge Abstract Database (DAD). The long-form census data represent about 20% of the non-institutional population and provide information about the Canadian population by generation status, place of birth and period of arrival of the first generation, as well as socioeconomic characteristics.

The DAD contains annual information about inpatient hospitalizations, excluding the province of Quebec, which does not routinely submit data to the DAD. As a result, immigrants living in Quebec were excluded from this study, as were hospitalizations of residents of other provinces that occurred in Quebec.

Approximately 4.65 million census long-form respondents (excluding Quebec) were linked to the DAD for the three fiscal years from 2006/2007 to 2008/2009. A hierarchical deterministic linkage using date of birth, sex, and residential postal code was conducted. Postal code information from the Historical Tax File was used to account for changes in residence. The weighted coverage rates in the linked data were relatively high (78% to 80%). A validation study[23] concluded that the linked file is suitable for health-related research and is broadly representative of immigrants in Canada.

Additional information about the linkage process and results are reported elsewhere.[23] The linkage was approved by Statistics Canada's Policy Committee[24] and is governed by the Directive on Record Linkage.[25]

Study sample

The study cohort consisted of people aged 30 or older who were living in urban communities—census metropolitan areas (CMAs) or census agglomerations (CAs)[26] outside the territories—at the time of the 2006 Census (May 16, 2006). The majority of immigrants, especially recent arrivals, live in these urban communities.[27] Non-permanent residents (people in Canada on employment or student authorizations) and refugee claimants were excluded. The final study cohort comprised 2,212,755 respondents, among whom 548,460 hospitalizations were recorded over the three years.

Measures

Generation status was defined based on immigrant status and parental place of birth. First-generation (G1) respondents are those who were, or had been, landed immigrants in Canada. A landed immigrant is a person who is not a Canadian citizen by birth, but who has been granted the right to live in Canada permanently.[1] Immigrants were categorized by their period of arrival: long-term (before 1996) or recent (from 1996 to 2006). Second-generation (G2) respondents are non-immigrants with at least one parent born outside Canada. Third-plus-generation (G3+) respondents are non-immigrants with both parents born in Canada. Although the study focuses on immigrants from China (including Hong Kong) and South Asia (Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka), these origins are not singled out in the G3+ comparison population.

Additional covariates from the census are age group (30 to 49, 50 to 64, and 65 or older), sex, secondary school graduation (yes/no), and before-tax low-income status (yes/no/not applicable).The low-income measure is based on the low-income cut-off threshold, determined by the average spending on food, clothing and shelter of all Canadians. A person is identified as in a low-income situation if the total income of his or her economic family (or the person if not in an economic family) was below the low-income threshold, which varies by economic family size and the size of the area of residence.[26]

The primary outcome is at least one inpatient acute-care hospitalization between April 1, 2006 and March 31, 2009. Two types of hospitalization are considered in this analysis: all-cause, excluding those related to pregnancy (ICD10 codes O00 to O99,) and circulatory disease-related (ICD10 codes I00 to I93), which accounted for 17% (91,821) of discharges in the linked database.

Statistical methods

Descriptive statistics were produced to profile the study population by generation status and by the selected origins: South Asia and China. Crude and age-standardized hospitalization rates (ASHR) were derived for all-cause and circulatory disease-related hospitalizations using the overall cohort population as the reference population. Statistical testing for differences in age-standardized rates was conducted using logarithmic transformation to adjust for the skewness in the distribution of the standardized rates for inferential purposes in analysis of rare events.[28] Multivariate logistic regressions were used to estimate the odds of being hospitalized at least once, by generation status, using G3+ as the reference population. Separate models were estimated by sex and by origin. Two models were estimated: 1) age-adjusted, and 2) fully adjusted, controlling for age, low-income status, and secondary school graduation status. Analysis was conducted using SAS version 9.2.[29]

Results

First-generation immigrants (G1) made up 31% of the urban population aged 30 or older; the second generation (G2) made up 21% (Table 1). The third-plus generation (G3+) accounted for the remaining 48%.

Among G1 respondents, 23% were recent immigrants (1996 to 2006), and 25% were from South Asia or China.

Approximately 3% of G2 respondents reported that their parent(s) were born in South Asia or China. G2 respondents of South Asian and Chinese descent were relatively young—85% and 79%, respectively, were aged 30 to 49, compared with about 50% for G2 overall.

Distributions by education level were similar across generations, with about 80% having graduated from secondary school. However, more than 90% of G2 respondents of South Asian and Chinese descent were secondary school graduates.

A relatively large percentage of G1 respondents lived in low-income situa-

tions: 18% versus 10% of G2 and G3+. The figure was particularly high—27%— for Chinese immigrants.

A rising gradient in age-standardized hospitalization rates (ASHRs) was observed across the generations (Table 2). All-cause ASHRs for G1, G2 and G3+ were 609, 792 and 839 per 10,000, respectively; the corresponding ASHRs for circulatory disease were 119, 142 and 152 per 10,000. The ASHRs for G1 and G2 were significantly lower than those for G3+. Patterns were similar among those of South Asian and Chinese descent. The lowest ASHRs were among G1 from China.

Logistic regression revealed rising odds of all-cause hospitalization by generation for both men and women (Table 3). Compared with G3+, the age-adjusted odds of at least one hospitalization among men were 0.50 for recent G1, 0.79 for long-term G1, and 0.96 for G2. The trend was similar for women. Full adjustment for education and income reduced the differences, but they remained significant. These patterns prevailed among those of South Asian and Chinese descent.

The results for circulatory disease-related hospitalizations were similar, but some differences emerged (Table 3). For men, differences between G2 and G3+ were not significant when adjusting for covariates. For women, the odds of hospitalization for G2 converged with G3+ even before adjustment.

Results varied by origin, with higher odds of circulatory disease-related hospitalization among people of South Asian descent, and lower odds among those of Chinese descent. Among South Asians, the odds of at least one circulatory disease-related hospitalization were not significantly lower for G2 men and women, or for long-term G1 men. Among the Chinese, even after adjustment, the odds of at least one circulatory disease-related hospitalization were significantly lower for G1 and G2, compared with G3+.

Table 1
Selected characteristics of long-form 2006 Census respondents aged 30 or older in urban areas, by generation status and South Asian or Chinese descent, Canada excluding Quebec and territories, 2006

		Non-immigrants				Immigrants		
		Third-plus generation (G3+)	Second generation (G2)			First generation (G1)		
Characteristics	Total	Total	Total	South Asia	China†	Total	South Asia	China†
Number	2,212,755	1,058,300	468,755	4,755	8,460	745,700	88,320	91,290
% distribution	100	47.8	21.2	0.2	0.4	33.7	4.0	4.1
				Column %				
Age group (years)								
30 to 49	49	53	49	85	79	45	59	52
50 to 64	30	32	23	9	12	31	27	28
65 or older	21	15	28	7	9	24	14	20
Male	48	48	48	49	51	47	51	46
Years since immigration								
Less than 10	...	...	...	...	...	23	44	37
10 or more	...	...	...	...	...	77	56	63
Secondary school graduation	77	77	79	93	93	77	79	78
Low-income situation	13	10	10	8	8	18	21	27

† includes Hong Kong
... not applicable
Source: 2006 Census of Canada, long-form.

Table 2
All-cause and circulatory disease-related crude and age-standardized hospitalization rates per 10,000 population, by generation status and South Asian or Chinese descent, long-form 2006 Census respondents aged 30 or older in urban areas, Canada excluding Quebec and territories, 2006/2007 to 2009/2010

	Total			South Asia		China†	
	Non-immigrants		Immigrants	Non-immigrants	Immigrants	Non-immigrants	Immigrants
Type of hospitalization	Third-plus generation (G3+)†	Second generation (G2)	First generation (G1)	Second generation (G2)	First generation (G1)	Second generation (G2)	First generation (G1)
All-cause excluding pregnancy							
Crude rate	757	897	664	362	466	372	332
Age-standardized rate	839	792*	609*	597*	544*	578*	356*
Circulatory disease-related							
Crude rate	130	169	133	52	105	43	45
Age-standardized rate	152	142*	119*	125	129*	79*	46*

† reference group
‡ includes Hong Kong
* significantly different from reference group ($p < 0.05$)
Notes: Total cohort population was used for age-standardization. Statistical testing was conducted only for age-standardized rates.
Source: Linked 2006 Census-2006/2007 to 2009/2010 Discharge Abstract Database.

Discussion

Convergence in hospitalization rates over immigrant generations was apparent for both men and women. Recent immigrants were the least likely to have had at least one hospitalization during the 2006/2007-to-2008/2009 period, followed by long-term first-generation, and then, second-generation Canadians. All three groups were less likely to have been hospitalized, compared with the third-plus generation. While a trend toward convergence emerged for circulatory disease-related hospitalizations, second-generation Canadians overall were no different from the third-plus generation, especially for women. This was more pronounced among South Asians than among those of Chinese descent.

Convergence of hospitalization rates in successive generations is consistent with the theory that immigrants tend to be healthier upon arrival, but that their health deteriorates over time.[30,31] It is argued that as immigrants and their offspring integrate into the host society, they adopt the norms, attitudes and behaviours of the new country, and experience the accompanying health consequences.[32]

Table 3
Age- and fully-adjusted odds ratios relating generation status and South Asian or Chinese descent to all-cause and circulatory disease-related hospitalization, by sex, long-form 2006 Census respondents aged 30 or older in urban areas, Canada excluding Quebec and territories, 2006/2007 to 2009/2010

	All-cause hospitalization (excluding pregnancy)						Circulatory disease-related hospitalization					
Sex, generation status and South Asian or Chinese descent	Age-adjusted odds ratio	95% confidence interval		Fully adjusted† odds ratio	95% confidence interval		Age-adjusted odds ratio	95% confidence interval		Fully adjusted† odds ratio	95% confidence interval	
		from	to		from	to		from	to		from	to
Men												
Third-plus generation (G3+)‡	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Total												
Second generation (G2)	0.95*	0.94	0.97	0.97*	0.96	0.99	0.95*	0.93	0.98	0.97	0.94	1.00
First generation (G1)												
Long-term (10 or more years)	0.78*	0.77	0.79	0.79*	0.78	0.80	0.82*	0.80	0.84	0.83*	0.81	0.85
Recent (less than 10 years)	0.49*	0.48	0.51	0.49*	0.48	0.51	0.55*	0.52	0.59	0.56*	0.52	0.60
South Asia												
Second generation (G2)	0.71*	0.60	0.84	0.74*	0.63	0.88	0.87	0.64	1.20	0.91	0.65	1.25
First generation (G1)												
Long-term (10 or more years)	0.74*	0.71	0.77	0.75*	0.72	0.78	0.97	0.91	1.04	1.01	0.94	1.08
Recent (less than 10 years)	0.50*	0.47	0.53	0.49*	0.46	0.52	0.71*	0.64	0.79	0.71*	0.64	0.79
China§												
Second generation (G2)	0.64*	0.56	0.72	0.67*	0.59	0.76	0.52*	0.40	0.69	0.55*	0.42	0.72
First generation (G1)												
Long-term (10 or more years)	0.44*	0.42	0.46	0.43*	0.41	0.45	0.37*	0.34	0.41	0.37*	0.33	0.40
Recent (less than 10 years)	0.31*	0.28	0.34	0.30*	0.27	0.32	0.24*	0.19	0.29	0.23*	0.19	0.28
Women												
Third-plus generation (G3+)‡	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Total												
Second generation (G2)	0.96*	0.94	0.97	0.97*	0.96	0.99	0.97	0.94	1.00	0.98	0.95	1.01
First generation (G1)												
Long-term (10 or more years)	0.74*	0.73	0.75	0.74*	0.73	0.75	0.79*	0.77	0.82	0.78*	0.75	0.90
Recent (less than 10 years)	0.53*	0.52	0.52	0.51*	0.5	0.53	0.52*	0.48	0.56	0.49*	0.45	0.54
South Asia												
Second generation (G2)	0.74*	0.62	0.85	0.73*	0.63	0.89	0.67	0.42	1.07	0.71	0.44	1.13
First generation (G1)												
Long-term (10 or more years)	0.67*	0.64	0.70	0.66*	0.63	0.69	0.77*	0.70	0.85	0.74*	0.67	0.82
Recent (less than 10 years)	0.54*	0.51	0.57	0.51*	0.48	0.54	0.67*	0.58	0.78	0.61*	0.52	0.71
China§												
Second generation (G2)	0.72*	0.64	0.80	0.74*	0.66	0.83	0.63*	0.46	0.88	0.67*	0.48	0.92
First generation (G1)												
Long-term (10 or more years)	0.43*	0.41	0.45	0.41*	0.39	0.43	0.34*	0.30	0.38	0.31*	0.27	0.34
Recent (less than 10 years)	0.36*	0.34	0.39	0.34*	0.31	0.36	0.25*	0.20	0.32	0.23*	0.18	0.29

† adjusted for age, secondary school graduation, and low income status
‡ reference group G3+ is for overall population
§ includes Hong Kong
* significantly different from reference group ($p < 0.05$)
... not applicable
Source: Linked 2006 Census-2006/2007 to 2009/2010 Discharge Abstract Database.

Research on cardiovascular disease points to acculturation as a contributor to the increasing risk among immigrants and the second generation.[33] For instance, people of Mexican origin who were born in the United States had higher levels of hypertension, smoking, cholesterol, diabetes and obesity than their Mexican immigrant counterparts [34,35] and consumed less "heart healthy diets."[36] In Canada, cardiovascular disease risks among South Asians and Chinese immigrants tend to increase with duration of residence.[11]

The present study found higher odds of circulatory disease-related hospitalization among first- and second-generation South Asians, compared with the Chinese. Similar findings have been reported in the United States, the United Kingdom, South Africa, the Caribbean, and Singapore.[5,37-39] For example, in the United Kingdom, an excess risk of coronary artery problems among first- and second-generation South Asians was reported.[40] A study of Indian immigrants in London, England found that they had higher body mass index, systolic blood pressure and fasting blood glucose than their siblings in India.[41] South Asians in Canada have a high prevalence of risk factors such as diabetes, which may explain some of the findings in this study.[7,11,42] By contrast, the Chinese have the most favourable circulatory disease risk factor profile of the major ethnic groups in Canada, although it worsens with duration of residence. Contrary to these findings, an Australian study reported that the risk of circulatory- and diabetes-related mortality among older South Asians decreased with duration of residence, while immigrants from the United Kingdom and Ireland experienced increasing mortality over time.[43]

People of South Asian descent tend to have one of the highest rates of circulatory disease in the world.[6,44] Nonetheless, results of this study revealed a lower risk of hospitalization among recent immigrants from South Asia, compared with third-plus-generation Canadians. This may reflect the selection process that involves medical screening of potential immigrants.[45] However, additional analyses (data not shown) found relatively high circulatory disease-related hospitalization rates among younger South Asians, especially G1, which is consistent with an early onset of heart problems.[46,47] As well, long-term male immigrants from South Asia did not differ from G3+ in the likelihood of experiencing a circulatory disease-related hospitalization. Case-control research has found that South Asians tend to be hospitalized later in the course of acute myocardial infarction,[48] which may indicate differences in care-seeking behaviour and/or cultural or language problems.

This study found that people of Chinese descent, both G1 and G2, had significantly lower odds of circulatory disease-related hospitalization than G3+, even with adjustment for education and income. Consistent with these results, an analysis of linked census and mortality data[3] revealed lower circulatory disease mortality rates among recent and long-term and immigrants (G1) from East Asia (Hong Kong, Japan, Macao, Mongolia, North Korea, People's Republic of China, Taiwan, Singapore, South Korea), compared with the Canadian-born population (largely G3+). The same study showed that South Asian male immigrants who arrived after 1971 also had significantly lower circulatory disease mortality rates, but South Asian female immigrants' mortality rates were similar to those of Canadian-born women. The latter is not consistent with the significantly lower hospitalization rates for G1 South Asian women found in this analysis. This indicates potential underutilization of circulatory disease-related health care by female immigrants from South Asia.

Limitations

The limitations of the linked census-hospitalization dataset include the absence of information about diet, smoking, exercise and social capital (connectedness and support). A lack of information about non-hospital care received from family doctors and specialists or about alternative care, which may be more prevalent among some ethnic groups, is also important because low hospitalization rates may reflect efficient use of and access to primary or alternative health care, not better health. As well, the G2 South Asian and Chinese

What is already known on this subject?

- Canadian studies of immigrant integration have explored economic outcomes for the second generation, but patterns of health and health care use by generation status have received little attention thus far.
- South Asian immigrants have a circulatory disease mortality risk similar to the Canadian-born population, but higher than other immigrant groups such as the Chinese.
- There is a need to determine if the relatively high circulatory disease mortality risk among South Asians is reflected in hospitalization, and if the health risks affect subsequent generations.

What does this study add?

- Using linked census-hospital data, this study examined all-cause (excluding pregnancy) and circulatory disease-related hospitalizations among first- and second-generation of immigrants, particularly, South Asians and Chinese.
- Based on age-standardized hospitalization rates, South Asian immigrants' health advantage in circulatory disease is lost by the second generation.
- Among the Chinese, all-cause and circulatory disease-related hospitalization risk generally increased across generations but remained significantly lower than for Canadians overall.

populations are still relatively young, and their group sizes are small. For example, the unadjusted and adjusted odds of circulatory disease-related hospitalization among G2 women of South Asian descent—0.67 and 0.71—would seem to be significantly low, but the confidence intervals were wide. Further research is needed to determine if this is a sample size issue or if circulatory disease-related hospitalizations are actually less prevalent in this group. Finally, linkage of the long-form census with hospital records could differ by place of birth. In particular, linkage of 2006 Census results to tax data to obtain changes in postal code information, which relied on names, may yield lower linkage rates for certain subgroups (for example, Chinese). This would be an issue only if the link was accomplished via the additional postal code information derived from the tax data. The majority of links for this study were established in the first iteration with an exact match of the postal code on the census record.

Conclusion

The results of this analysis suggest that immigrants' health advantage diminishes in the second generation, particularly for circulatory disease. For those of South Asian descent, the health advantage was lost in the second generation, while for those of Chinese descent, the advantage decreased, but persisted compared with the third-plus generation. These findings have potentially important implications for public health and future needs for health care services.

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